

CLAIMS

1. An audio coding system for encoding and decoding an audio signal, said system including an encoder and a decoder, said encoder comprising:-

5 means for decomposing said audio signal into an upper and a lower sub-band signal;

lower sub-band coding means for encoding said lower sub-band signal;

10 upper sub-band coding means for encoding at least the non-periodic component of said upper sub-band signal according to a source-filter model;

15 said decoder means comprising means for decoding said encoded lower sub-band signal and said encoded upper sub-band signal, and for reconstructing therefrom an audio output signal,

wherein said decoding means comprises filter means and excitation means for generating an excitation signal for being passed by said filter means to produce a synthesised audio signal, said excitation means being operable to 20 generate an excitation signal which includes a substantial component of synthesised noise in an upper frequency band corresponding to the upper sub-band of said audio signal.

2. An audio coding system according to Claim 1, wherein said decoder means comprises lower sub-band decoding means and upper sub-band decoding means, for receiving and decoding the encoded lower and upper sub-band signals respectively.

3. An audio coding system according to Claim 1 or 2, wherein said upper frequency band of said excitation signal substantially wholly comprises a synthesised noise signal.
4. An audio coding system according to Claim 1 or 2, 5 wherein said excitation signal comprises a mixture of a synthesised noise component and a further component corresponding to one or more harmonics of said lower sub-band audio signal.
5. An audio coding system according to any of the 10 preceding Claims, wherein said upper sub-band coding means comprises means for analysing and encoding said upper sub-band signal to obtain an upper sub-band energy or gain value and one or more upper sub-band spectral parameters.
6. An audio coding system according to Claim 5, wherein 15 said one or more upper sub-band spectral parameters comprise second order LPC coefficients.
7. An audio coding system according to Claim 5 or 6, 20 wherein said encoder means includes means for measuring the energy in said upper sub-band thereby to deduce said upper sub-band energy or gain value.
8. An audio coding system according to Claim 5 or 6, wherein said encoder means includes means for measuring the energy of a noise component in said upper band signal thereby to deduce said upper sub-band energy or gain value.
- 25 9. An audio coding system according to Claim 7 or Claim 8, including means for monitoring said energy in said upper sub-band signal, comparing this with a threshold derived from at least one of said upper and lower sub-band energies,

and for causing said upper sub-band encoding means to provide a minimum code output if said monitored energy is below said threshold.

10. An audio coding system according to any of the preceding Claims, wherein said lower sub-band coding means comprises a speech coder, and includes means for providing a voicing decision.

11. An audio coding according to Claim 10, wherein said decoder means includes means responsive to the energy in said upper band encoded signal and said voicing decision to adjust the noise energy in said excitation signal dependent on whether the audio signal is voiced or unvoiced.

12. An audio coding system according to any of Claims 1 to 9, wherein said lower sub-band coding means comprises an MPEG audio coder.

13. An audio coding system according to any of the preceding Claims, wherein said upper sub-band contains frequencies above 2.75kHz and said lower sub-band contains frequencies below 2.75kHz.

20 14. An audio coding system according to any of Claims 1 to 12, wherein said upper sub-band contains frequencies above 4kHz, and said lower sub-band contains frequencies below 4kHz.

15. An audio encoder according to any of Claims 1 to 12, 25 wherein said upper sub-band contains frequencies above 5.5kHz and said lower sub-band contains frequencies below 5.5kHz.

16. An audio encoder according to any of the preceding Claims, wherein said upper sub-band coding means encodes

said noise component with a bit rate of less than 800 bps and preferably of about 300 bps.

17. An audio coding system according to Claim 5 or any Claim dependent thereon, wherein said upper sub-band signal 5 is analysed with relatively long frame periods to determine said spectral parameters and with relatively short frame periods to determine said energy or gain value.

18. An audio coding method for encoding and decoding an audio signal, which method comprises:-

10 decomposing said audio signal into an upper and a lower sub-band signal;

encoding said lower sub-band signal;

encoding at least the non-periodic component of said upper sub-band signal according to a source-filter model,

15 and

decoding said encoded lower sub-band signal and said encoded upper sub-band signal to reconstruct an audio output signal;

wherein said decoding step includes providing an 20 excitation signal which includes a substantial component of synthesised noise in an upper frequency bandwidth corresponding to the upper sub-band of said audio signal, and passing said excitation signal through a filter means to produce a synthesised audio signal.

25 19. An audio encoder for encoding an audio signal, said encoder comprising:-

means for decomposing said audio signal into an upper and a lower sub-band signal;

lower sub-band coding means for encoding said lower

sub-band signal, and

upper sub-band coding means for encoding at least a noise component of said upper sub-band signal according to source-filter model.

- 5 20. A method of encoding an audio signal which comprises decomposing said audio signal into an upper and a lower sub-band signal, encoding said lower sub-band signal and encoding at least a noise component of said upper sub-band signal according to a source-filter model.
- 10 21. An audio decoder for decoding an audio signal encoded in accordance with the method of Claim 20, said decoder comprising filter means and excitation means for generating an excitation signal for being passed by said filter means to produce a synthesised audio signal, said excitation means being operable to generate an excitation signal which includes a substantial component of synthesised noise in an upper frequency band corresponding to the upper sub-bands of said audio signal.
- 15 22. A method of decoding an audio signal encoded in accordance with the method of Claim 20, which comprises providing an excitation signal which includes a substantial component of synthesised noise in an upper frequency bandwidth corresponding to the upper sub-band of the input audio signal, and passing said excitation signal through a filter means to produce a synthesised audio signal.
- 20 23. A coder system for encoding and decoding a speech signal, said system comprising encoder means and decoder means, said encoder means including:-
filter means for decomposing said speech signal into

lower and upper sub-bands together defining a bandwidth of at least 5.5 kHz;

5 lower sub-band vocoder analysis means for performing a relatively high order vocoder analysis on said lower sub-band to obtain vocoder coefficients including LPC coefficients representative of said lower sub-band;

10 upper sub-band vocoder analysis means for performing a relatively low order vocoder analysis on said upper sub-band to obtain vocoder coefficients including LPC coefficients representative of said upper sub-band;

coding means for coding vocoder parameters including said lower and upper sub-band coefficients to provide an encoded signal for storage and/or transmission, and

15 said decoder means including:-

decoding means for decoding said encoded signal to obtain vocoder parameters including said lower and upper sub-band vocoder coefficients;

20 synthesising means for constructing an LPC filter from the vocoder parameters from said upper and lower sub-bands and for synthesising said speech signal from said filter and from an excitation signal.

24. A voice coder system according to Claim 23, wherein said lower sub-band vocoder analysis means and said upper sub-band vocoder analysis means are LPC vocoder analysis 25 means.

25. A voice coder system according to Claim 24, wherein said lower sub-band LPC analysis means performs a tenth order or higher analysis.

26. A voice coder system according to Claim 24 or Claim 25,

wherein said high band LPC analysis means performs a second order analysis.

27. A voice coder system according to any of Claims 23 to 26, wherein said synthesising means includes means for re-synthesising said lower sub-band and said upper sub-band and for combining said re-synthesised lower and higher sub-bands.

28. A voice coder system according to Claim 27, wherein said synthesising means includes means for determining the power spectral densities of the lower sub band and the upper sub-band respectively, and means for combining said power spectral densities to obtain a relatively high order LPC model.

29. A voice coder system according to Claim 28, wherein said means for combining includes means for determining the autocorrelations of said combined power spectral densities.

30. A voice coder system according to Claim 29, wherein said means for combining includes means for determining the autocorrelations of the power spectral density functions of said lower and upper sub-bands respectively, and then combining said autocorrelations.

31. A voice encoder apparatus for encoding a speech signal, said encoder apparatus including:-

filter means for decomposing said speech signal into lower and upper sub-bands;

low band vocoder analysis means for performing a relatively high order vocoder analysis on said lower sub-band signal to obtain vocoder coefficients representative of said lower sub-band;

upper band vocoder analysis means for performing a relatively low order vocoder analysis on said upper sub-band signal to obtain vocoder coefficients representative of said upper sub-band, and

5 coding means for coding said low and high sub band vocoder coefficients to provide an encoded signal for storage and/or transmission.

32. A voice decoder apparatus for synthesising a speech signal coded by a coder in accordance with Claim 31, and
10 said coded speech signal comprising parameters including LPC coefficients for a lower sub-band and an upper sub-band, said decoder apparatus including:

decoding means for decoding said encoded signal to obtain LPC parameters including said lower and upper sub-
15 band LPC coefficients, and

synthesising means for constructing an LPC filter from the vocoder parameters for said upper and said lower sub-bands and for synthesising said speech signal from said said filter and from an excitation signal.